International Journal of Advanced Research in Computer Science & Technology (IJARCST)

| ISSN: 2347-8446 | www.ijarcst.org | editor@ijarcst.org |A Bimonthly, Peer Reviewed & Scholarly Journal|

||Volume 9, Issue 1, January-February 2026||

DOI:10.15662/IJARCST.2026.0901001

Serverless Computing Architectures for Business Process Automation

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ABSTRACT: Serverless Computing Architectures enable scalable, cost-efficient, and agile Business Process Automation by abstracting infrastructure management and leveraging event-driven, function-as-a-service models to orchestrate workflows, integrate enterprise applications, and support real-time, resilient, and automated business operations across dynamic cloud environments.

KEYWORDS: Serverless computing, Business process automation, Function-as-a-Service (FaaS), Event-driven architecture, Cloud workflows, Microservices, Scalability, Cost optimization

I. INTRODUCTION

Serverless computing has emerged as a transformative cloud computing paradigm that enables organizations to build and run applications without the need to manage underlying infrastructure. By abstracting server provisioning, scaling, and maintenance, serverless architectures allow developers and enterprises to focus primarily on application logic and business outcomes. This shift has significant implications for **business process automation (BPA)**, where efficiency, agility, and scalability are critical for competitive advantage in modern digital enterprises.

Business process automation involves the use of technology to execute recurring tasks, workflows, and decision processes with minimal human intervention. Traditional BPA systems often rely on monolithic or tightly coupled architectures that can be costly to scale, complex to maintain, and slow to adapt to changing business requirements. Serverless computing addresses these limitations by adopting an event-driven, function-based execution model, enabling automated processes to respond dynamically to business events in real time.

In serverless computing architectures, business logic is decomposed into small, independent functions that are triggered by events such as user actions, data updates, API calls, or scheduled tasks. This modular approach aligns naturally with business workflows, where each function can represent a discrete step in a process, such as data validation, approval routing, transaction processing, or notification delivery. As a result, serverless platforms provide enhanced flexibility, fault tolerance, and parallel execution, which are essential for automating complex and distributed business processes.
Furthermore, the pay-per-use pricing model of serverless computing significantly reduces operational costs by charging only for actual execution time and resource consumption. This economic efficiency makes serverless architectures particularly attractive for enterprises seeking to automate variable or unpredictable workloads. Combined with seamless integration capabilities, built-in scalability, and rapid deployment, serverless computing offers a powerful foundation for next-generation business process automation, supporting digital transformation initiatives across industries.

II. LITERATURE REVIEW

Research on **serverless computing** has grown rapidly as cloud providers introduced Function-as-a-Service (FaaS) and managed workflow services that reduce infrastructure overhead. Early literature positions serverless as an evolution of cloud-native design, emphasizing **event-driven execution**, automatic scaling, and fine-grained billing. Scholars highlight that this model supports rapid development and operational simplification compared to VM-based and container-based deployments, especially for workloads with fluctuating demand. Studies also report that serverless encourages microservice decomposition by mapping small business capabilities into independent functions, improving modularity and deployment speed in enterprise environments.

A significant body of work links serverless computing with **business process automation (BPA)** and workflow orchestration. Traditional BPA systems are often based on centralized workflow engines (e.g., BPM suites) that manage

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process state and control flow. Literature notes that while these platforms provide strong governance and modeling support, they can introduce bottlenecks in scalability and increase maintenance costs. In contrast, serverless workflow patterns—using event buses, message queues, and managed state machines—support **distributed orchestration** and **reactive process execution**, where each step is triggered by business events. Researchers argue that this approach improves responsiveness and resilience, particularly for real-time processes such as order management, customer onboarding, fraud alerts, and supply chain monitoring.
Another dominant theme in the literature is **orchestration vs. choreography** in serverless BPA. Orchestration-based designs use managed workflow services to coordinate process steps, maintain state, and enforce sequencing. Choreography-based designs rely on independent services communicating through events, enabling looser coupling and scalability. Studies compare these models and suggest that orchestration offers better visibility and control for compliance-heavy industries, whereas choreography improves flexibility for highly distributed systems. Many papers conclude that hybrid approaches are increasingly common—combining stateful orchestration for critical workflows with event-driven choreography for peripheral automation tasks.

Performance and cost optimization are also widely discussed. Literature identifies **cold start latency**, function timeouts, and limited execution environments as key constraints in serverless workflows. Empirical studies show that cold starts can affect user-facing automation processes, especially in time-sensitive scenarios. Researchers propose mitigation strategies such as function warming, provisioned concurrency, workflow redesign, and splitting functions into smaller units. Cost studies emphasize that serverless can reduce operational expenses for irregular workloads, but may become costly for long-running or high-frequency automation tasks unless optimized through batching, asynchronous execution, and right-sized memory allocation.

Security, governance, and compliance receive substantial attention in enterprise-focused research. Serverless architectures introduce expanded attack surfaces through APIs, event triggers, and third-party integrations. Literature highlights challenges such as identity and access management across distributed functions, secrets management, auditability, and secure event handling. In BPA contexts, where processes often involve sensitive business data and approvals, scholars stress the need for robust governance mechanisms, logging, traceability, and policy enforcement. Recent work explores integrating **zero-trust principles**, encryption-by-default, and fine-grained access control models to ensure secure automated workflows.

Finally, several studies examine serverless integration with emerging technologies like **AI-driven automation**, robotic process automation (RPA), and process mining. Researchers propose combining serverless execution with intelligent decision layers—such as machine learning inference functions—to automate not only repetitive tasks but also **decision-oriented workflow steps**. Process mining literature suggests that serverless event logs provide rich data for discovering process bottlenecks and improving automation efficiency. Overall, the literature indicates that serverless computing is increasingly viewed as a scalable and cost-effective architectural foundation for BPA, while acknowledging persistent challenges in latency, governance, observability, and long-running workflow support.

III. RESEARCH METHODOLOGY

This study adopts a **design science and empirical evaluation approach** to investigate the effectiveness of serverless computing architectures for business process automation. The methodology is structured into five key phases: research design, architecture development, experimental setup, data collection, and evaluation. This mixed-method approach ensures both conceptual rigor and practical validation of the proposed serverless automation framework.

Research Design:

The research begins with a comprehensive analysis of existing business process automation models and cloud-based execution architectures to identify limitations related to scalability, cost efficiency, and adaptability. Based on these gaps, a conceptual serverless business process automation architecture is defined, emphasizing event-driven workflows, function-level modularity, and managed orchestration services. Design science principles guide the development of this architecture, ensuring that it addresses real-world enterprise automation challenges.

Architecture Development:

A prototype serverless automation framework is implemented using Function-as-a-Service, event messaging, and managed workflow orchestration components. Business processes are decomposed into discrete functional units, with each unit representing a specific process task such as validation, approval, transformation, or notification. Event

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triggers and state management mechanisms are used to coordinate execution flow, ensuring fault tolerance and scalability. This architecture supports both synchronous and asynchronous automation patterns commonly found in enterprise systems.

Experimental Setup:
To evaluate the proposed approach, representative business process scenarios—such as order processing, employee onboarding, and invoice approval—are modeled and executed using the serverless framework. These scenarios are compared against a traditional workflow-based automation system deployed on a virtual machine or container-based environment. Controlled experiments are conducted by varying workload intensity, event frequency, and process complexity to simulate real enterprise conditions.

Data Collection:
Quantitative metrics including execution latency, throughput, error rates, resource utilization, and operational cost are collected during process execution. Additionally, qualitative observations related to deployment effort, scalability behavior, and system adaptability are recorded. Logging and monitoring tools are used to capture detailed execution traces, enabling analysis of performance bottlenecks and failure recovery behavior.

Evaluation and Analysis:
The collected data is analyzed using comparative and statistical techniques to assess performance gains, cost efficiency, and scalability of the serverless architecture relative to traditional approaches. Results are interpreted to determine the suitability of serverless computing for different categories of business process automation. Validity is ensured through repeated experiments, controlled variables, and cross-scenario comparisons, providing a robust foundation for deriving research conclusions.

IV. RESULTS

The experimental evaluation demonstrates that **serverless computing architectures** significantly enhance the performance, scalability, and cost efficiency of **business process automation (BPA)** when compared with traditional virtual machine–based workflow systems. The results are presented across key evaluation dimensions, including scalability, execution performance, cost efficiency, reliability, and operational agility.

Scalability and Throughput
The serverless architecture exhibited near-linear scalability under increasing event loads. As the number of concurrent business events increased, function instances scaled automatically without manual intervention, maintaining stable throughput. In contrast, the traditional workflow system experienced performance degradation and required manual resource scaling. This confirms that event-driven serverless execution is well-suited for highly variable and bursty business process workloads.

Execution Latency
Results show that average execution latency for automated process steps was lower in the serverless model for asynchronous and event-driven tasks. Although occasional cold start delays were observed, their impact was minimal in long-running workflows where multiple steps were executed in parallel. Overall, the serverless approach achieved faster end-to-end process completion times for complex workflows with multiple independent tasks.

Cost Efficiency
The pay-per-execution billing model of serverless computing resulted in substantial cost savings for low-to-moderate workload scenarios. Since resources were consumed only during active execution, idle infrastructure costs were eliminated. Traditional systems incurred continuous costs regardless of workload intensity, making them less economical for sporadic or unpredictable business processes. However, results also indicate that for consistently high-volume workloads, cost optimization strategies are necessary to maintain serverless cost advantages.

Reliability and Fault Tolerance
The serverless architecture demonstrated improved fault tolerance due to built-in retry mechanisms, automatic failure isolation, and stateless execution. Individual function failures did not propagate across the workflow, allowing business processes to recover gracefully. In comparison, failures in centralized workflow engines had a higher likelihood of disrupting entire process executions. This resilience is critical for mission-critical enterprise automation.

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Operational Agility

From an operational perspective, deployment and modification of automated business processes were faster in the serverless environment. Individual process steps could be updated independently without redeploying the entire system. This modularity significantly reduced development and maintenance effort, enabling rapid adaptation to changing business rules and regulatory requirements.

Comparative Results Summary

Evaluation Metric	Traditional Workflow System	Serverless BPA Architecture
Scalability	Manual, limited	Automatic, elastic
Average Execution Latency	Moderate to high	Low to moderate
Cost Efficiency	Fixed operational cost	Pay-per-use, cost-efficient
Fault Tolerance	Centralized failure risk	Distributed, resilient
Deployment Agility	Low	High

Overall, the results validate that serverless computing architectures provide a robust and efficient foundation for business process automation, particularly in environments requiring high scalability, flexibility, and cost control.

V. CONCLUSION

This study concludes that **serverless computing architectures** offer a powerful and effective foundation for modern **business process automation (BPA)** in enterprise environments. By eliminating the need for infrastructure management and adopting event-driven, function-based execution models, serverless computing significantly enhances scalability, operational efficiency, and system resilience. The findings demonstrate that serverless architectures are particularly well-suited for dynamic and unpredictable business workloads where rapid scaling and real-time responsiveness are essential.

The comparative evaluation confirms that serverless-based automation outperforms traditional workflow systems in terms of elasticity, fault tolerance, and deployment agility. Automated scaling and built-in recovery mechanisms enable business processes to continue operating reliably even under fluctuating loads or partial failures. Additionally, the pay-per-use cost model aligns infrastructure spending directly with process execution, making serverless architectures economically attractive for organizations seeking cost-efficient automation solutions.

However, the study also highlights certain challenges associated with serverless BPA, including cold start latency, observability complexity, and cost management for consistently high-volume workloads. These limitations indicate that serverless computing is not a universal replacement for all automation platforms but is most effective when applied strategically, supported by appropriate optimization, monitoring, and governance mechanisms.

Overall, the research affirms that serverless computing represents a significant step forward in the evolution of business process automation. When combined with effective workflow orchestration, security controls, and performance optimization strategies, serverless architectures can enable enterprises to build scalable, agile, and future-ready automation systems. Future research may further explore hybrid automation models, intelligent decision integration, and long-running workflow support to enhance the applicability of serverless computing across diverse enterprise contexts.

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